ASHRAE's New Headquarters: Applying Sustainable Development Principles in the Real World

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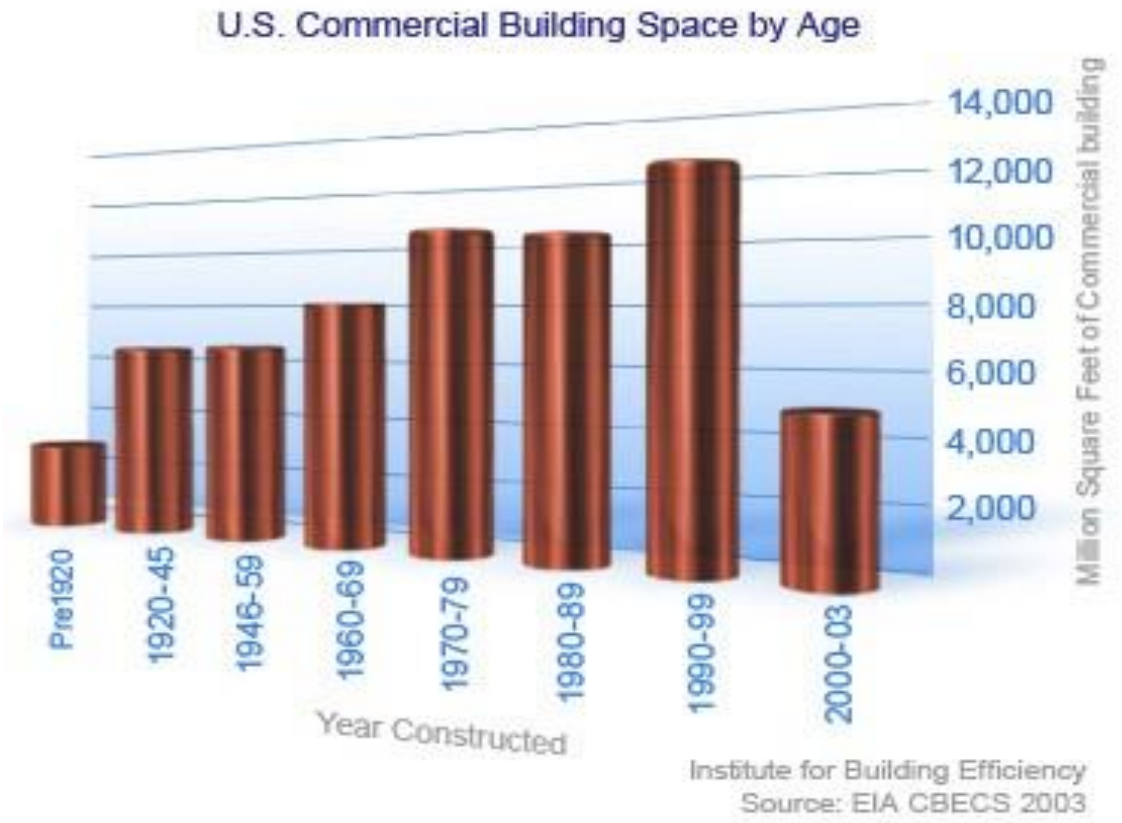
2019-20 ASHRAE President

New ASHRAE Headquarters

- *180 Technology Parkway, Peachtree Corners, GA*
- *66,000 sq. ft. building – 3 stories*
- *Built in 1970's*
- *Purchased in Dec. 2018*



PROJECT GOAL

In developed economies, at least half of the buildings that will be in use in 2050 *have already been built.*[4 5] According to a recent survey by the U.S. Energy Information Agency, 72 percent of floorstock in the U.S., or 46 billion square feet, belongs to buildings over twenty years old.[6]

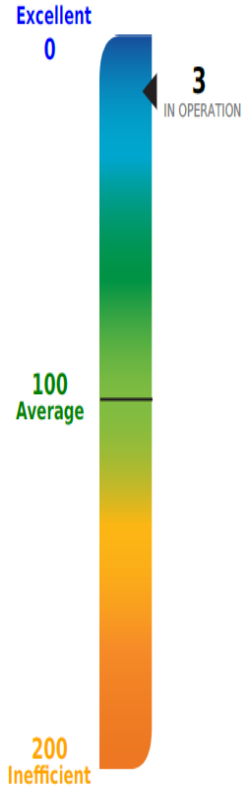
Project Goal:

To renovate a 1970's building into a high-performing net-zero-ready facility in a cost-effective method that can be replicated in the industry.

Owner's Project Requirements (OPR)

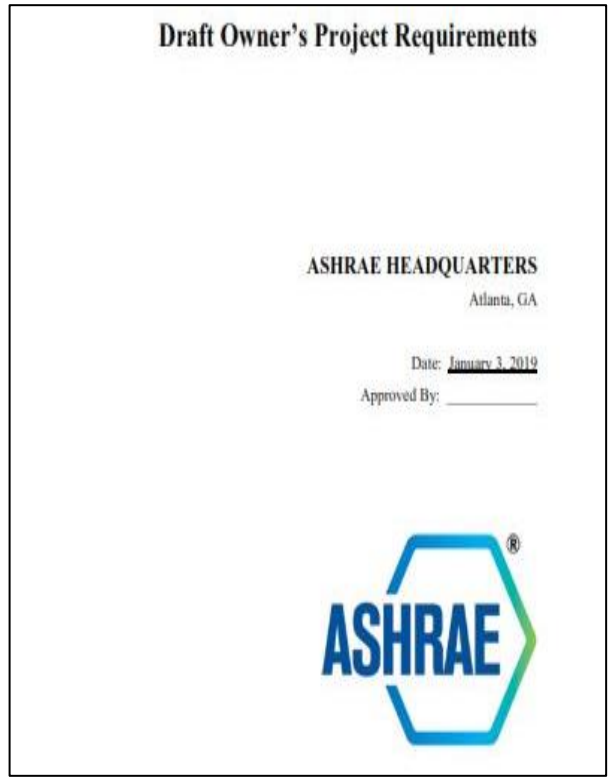
Item	OPR	Actual
ASHRAE 189.1-2017	Exceed Requirements	Achieved?
Demand Side Site Energy Consumption	21.4 kBTU/SF/year 15 kBTU/SF/year (stretch)	18.5 kBTU/SF/year
Water Efficiency	Obtain 11 of 11 LEED Water Use Efficiency Points	Unknown, LEED rating not sought
Daytime Plug Load	0.04 W/SF	Achieved?
Acoustics	Exceed requirements by 3-5 NC/RNC	Achieved?
Outside Air Rate	1.3 times ASHRAE 62.1	1.3 times achieved?
Outside Air Control	Demand Control Ventilation (DCV) for high occupancy spaces	Achieved?
Daylighting	Majority of Occupants achieve generous daylighting 55% of the time	57% on upper level >300 lux 23% on middle level >300 lux
Resiliency	Achieve resiliency in OPR	Achieved?

OWNER PROJECT REQUIREMENTS



Certification Programs Considered

- LEED
- Green Globes
- WELL Building
- FitWel
- Living Building Challenge
- **ASHRAE Building EQ**


Draft Owner's Project Requirements

ASHRAE HEADQUARTERS

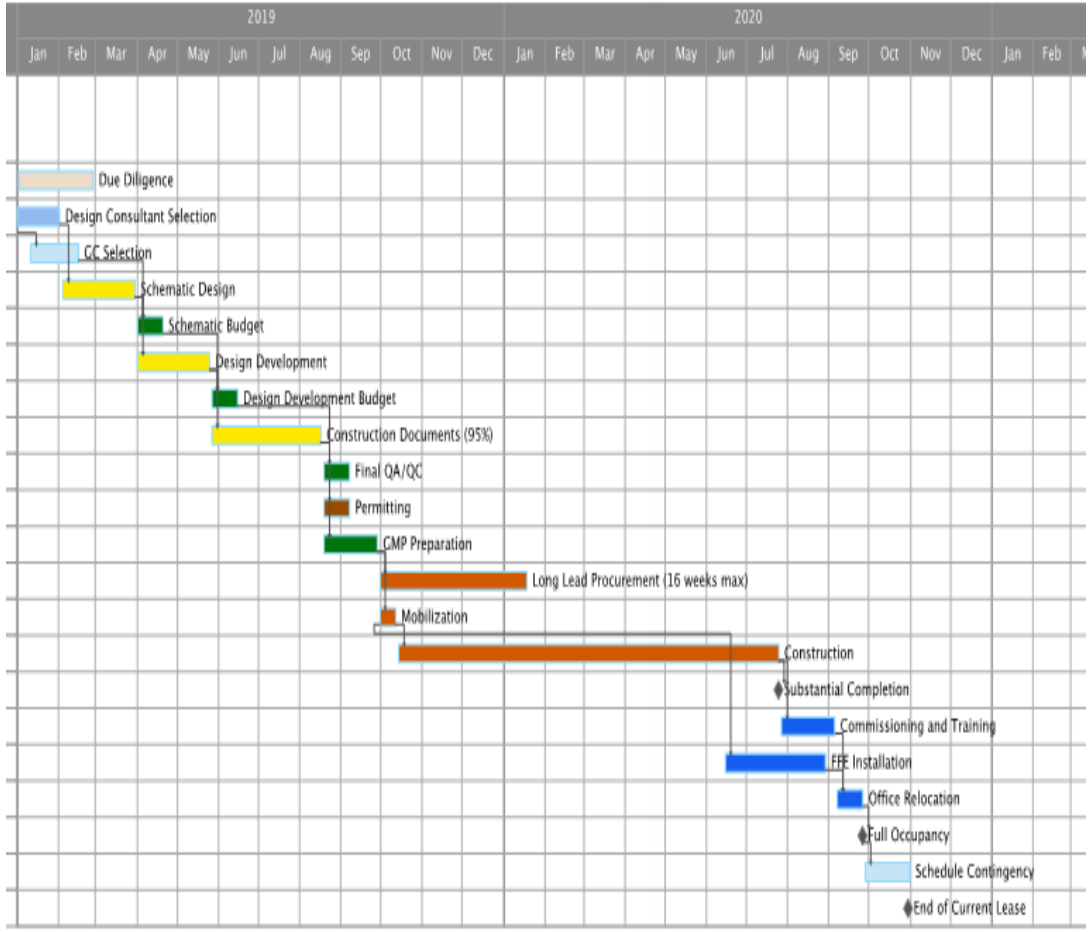
Atlanta, GA

Date: January 3, 2019

Approved By: _____

ASHRAE

Schedule Constraints



Jan., 2019: Design Team Selection

Feb., 2019: Construction Manager Selection

April 1, 2019: Schematic Design Complete

May 15, 2019: Design Development Complete

August 1, 2019: Construction Documents Complete

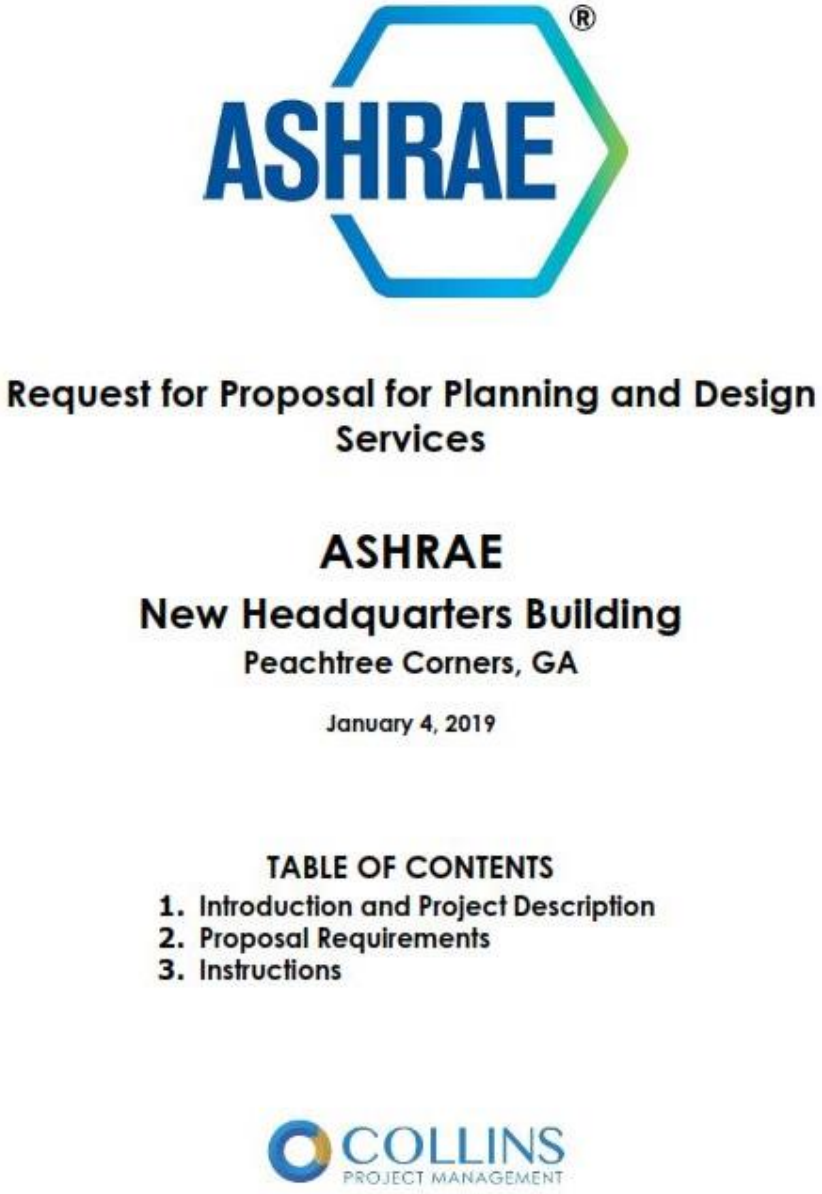
Sept. 15, 2019 – Start Construction Phase

August 15, 2020 – Construction Complete

August – Sept., 2020 – Commissioning Efforts

October 2020 – Full Occupancy

HOW DO WE ACHIEVE OUR PROJECT GOAL?



Request for Proposal for Planning and Design Services

ASHRAE

New Headquarters Building

Peachtree Corners, GA

January 4, 2019

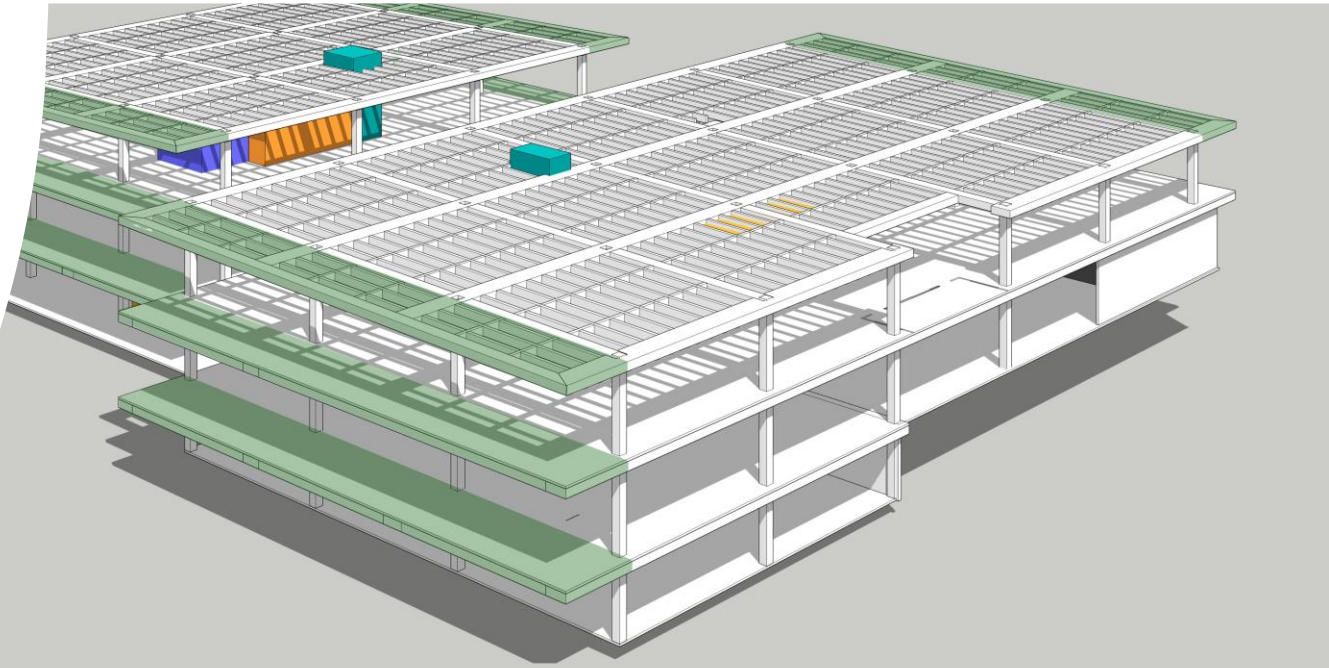
TABLE OF CONTENTS

1. Introduction and Project Description
2. Proposal Requirements
3. Instructions

- Set Construction Budget: $ 10,905,000 ($165/sq. ft. minus donations & PV)
- Total project budget including purchase of the property and fit-up: $20,000,000.
- Set Project Schedule: Must move in by Oct. 2020
- Set Project Criteria: Owner Project Requirements were set
- Hire a competent team!


STOP
STOP
STOP
STOP

Frame



Annual Air & Ground Temperature Profiles

Key Climate Factors: Atlanta Georgia

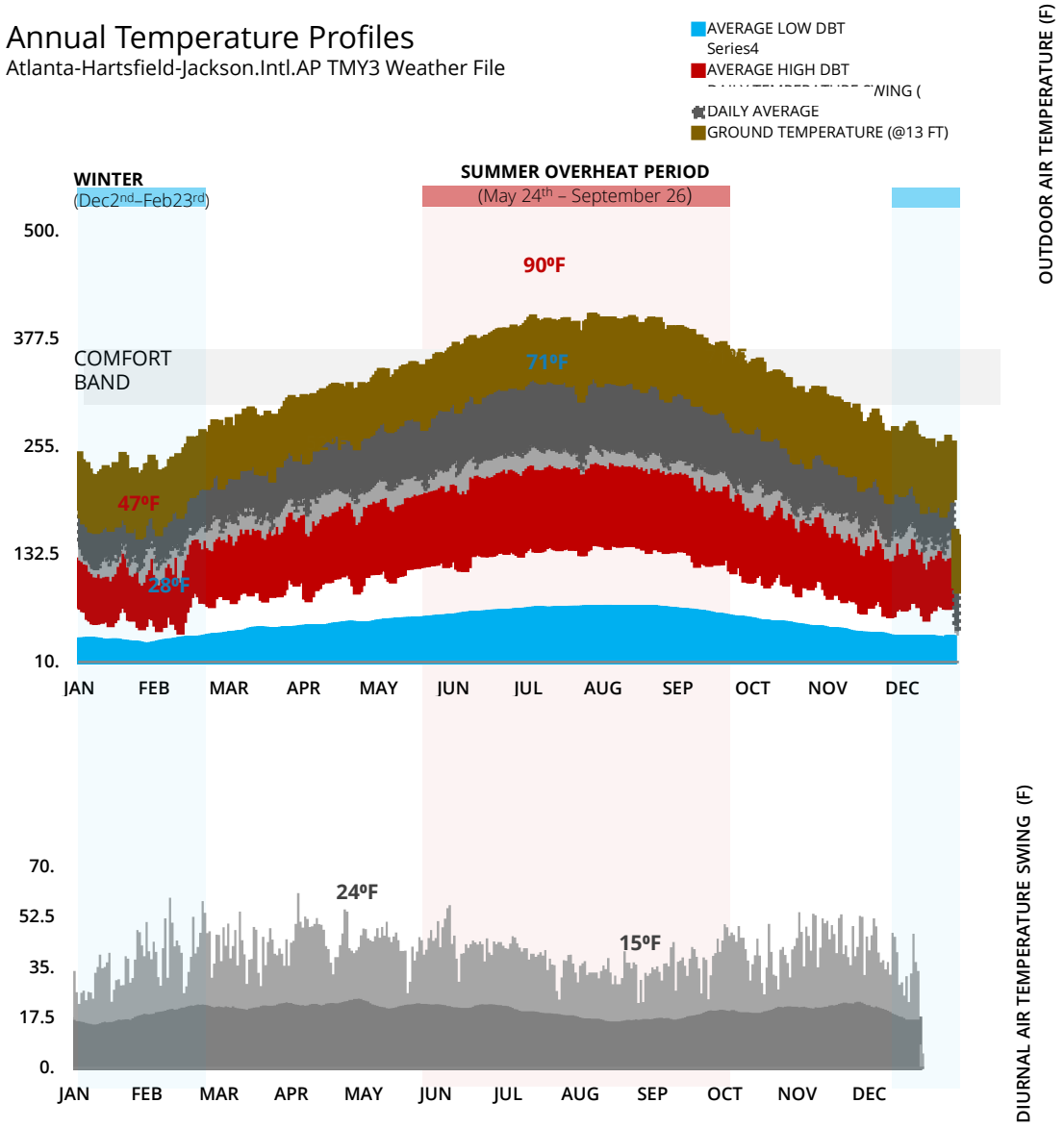
Key Climate Design Drivers

- **Summer:** May to September (Avg. OA>70ºF)
  - Extreme Hot Week Period: Jul 6 - Jul 12, Maximum Temp= 98.06F (36.7C). Future climate to be accounted for.
  - Exterior shading beneficial May-September to minimize unwanted summertime solar gains and enable low-energy passive cooling strategies.

- **Winter**: December to February (Avg. OA< 50ºF)
  - Extreme Cold Week Period : Jan 6 to Jan 12, Minimum Temp= 8.96F (-12.8C)
  - Leverage passive solar gains through south-facing façade fenestration to offset supplemental heating requirements.

- **Diurnal Swing**: Average Diurnal swing between 15-24ºF suggests an opportunity to leverage thermal mass to reduce peak indoor temperatures, reduce cooling energy, and improve occupant thermal comfort.

- **Ground and Water Temperatures:** Relatively stable ground (and Lake) temperatures suggest a potential heat source and sink for the HVAC system.



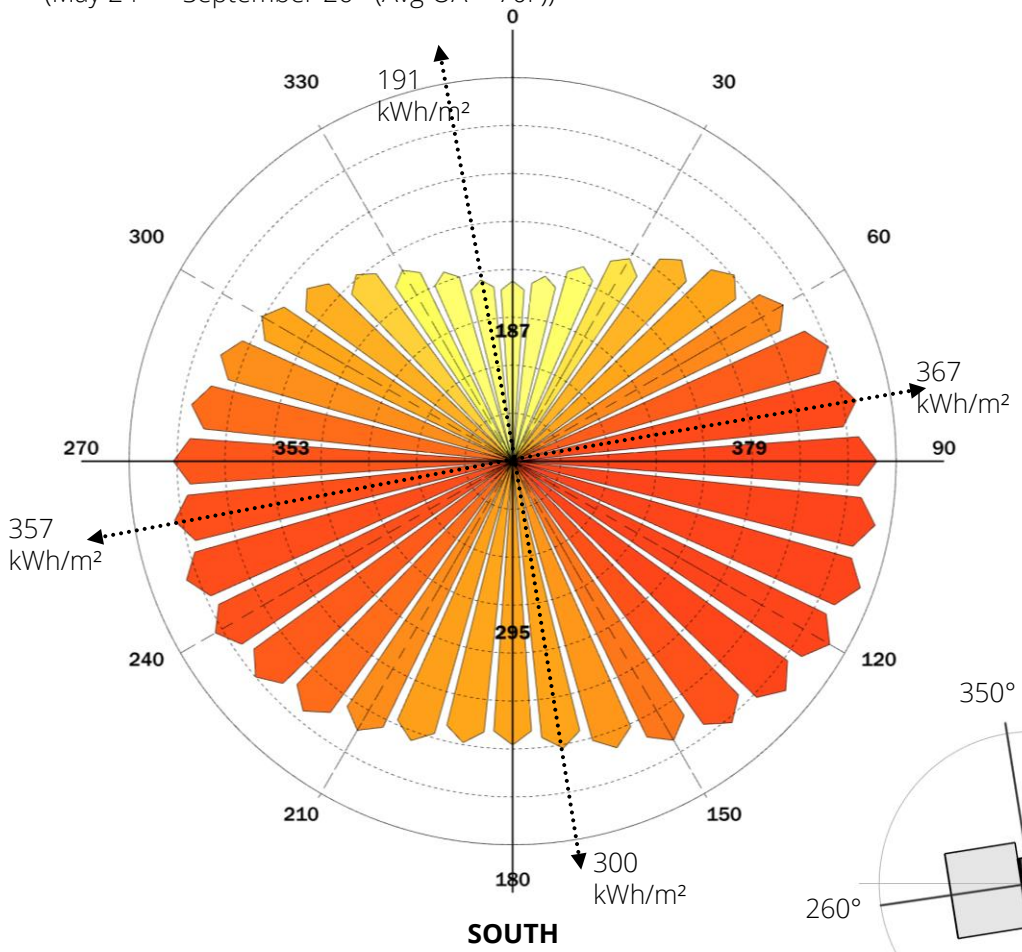
Incident Solar Radiation - SUMMER

Key Climate Factors: Atlanta Georgia

CUMULATIVE SEASONAL INSOLATION BY ORIENTATION (KWH/M²)

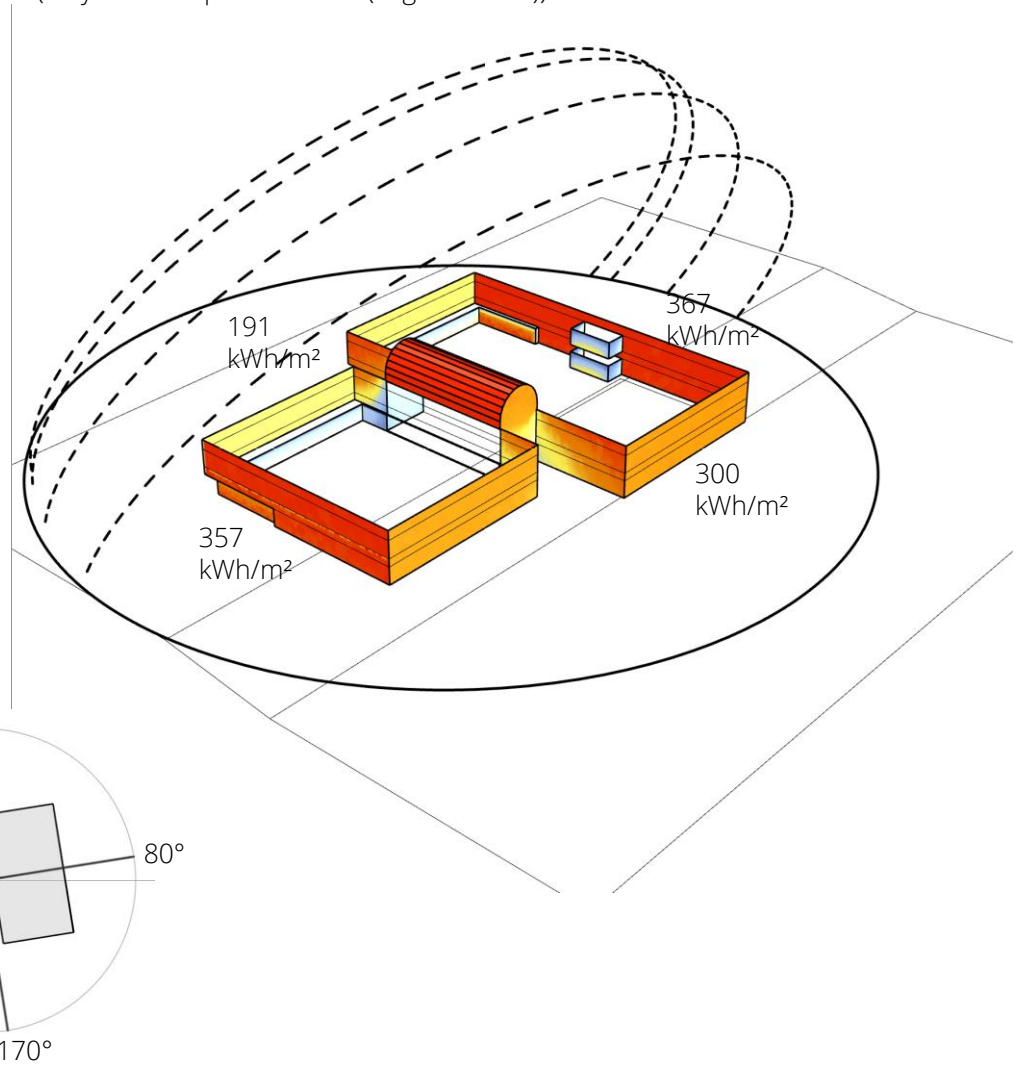
SUMMER INCIDENT SOLAR RADIATION BY FAÇADE ORIENTATION

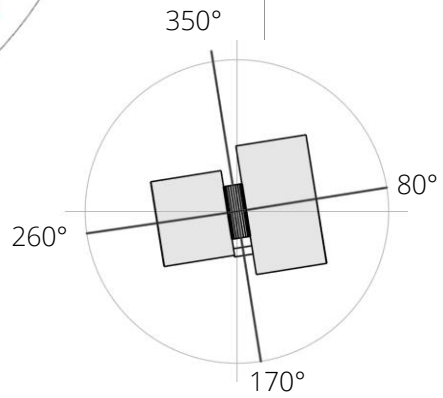
(May 24th –September 26th (Avg OA > 70F))



SUMMER INCIDENT SOLAR RADIATION - BASELINE

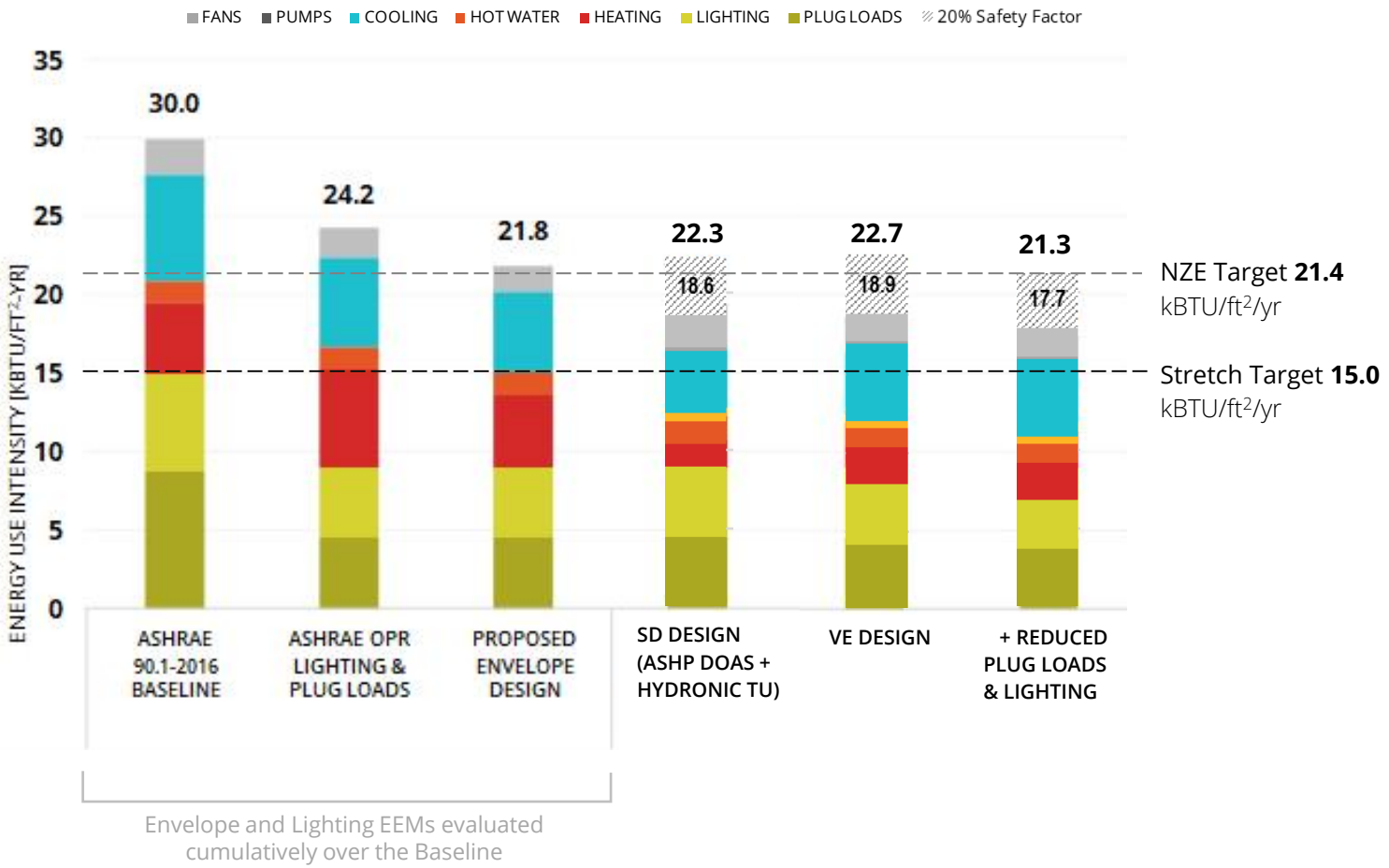
(May 24th –September 26th (Avg OA > 70F))





Path to NZE

ANNUAL SITE ENERGY USE



CHANGES TO THE 100% SD DESIGN

- Insulation removed at overhang
- 3” New Roof Insulation in lieu of 4”: R-30 assembly
- Existing Atrium to remain
- Skylights removed
- Detailed thermal zoning added to model based on latest floor plan
- Internal gains & diversities updated based on latest floor plan
- HVAC updated to match latest design

TAKEAWAYS

- 50% increase in heating energy
- 25% increase in cooling energy
- Atrium alone accounts for 15% of EUI
- With 20% safety factor, current design is above NZE target

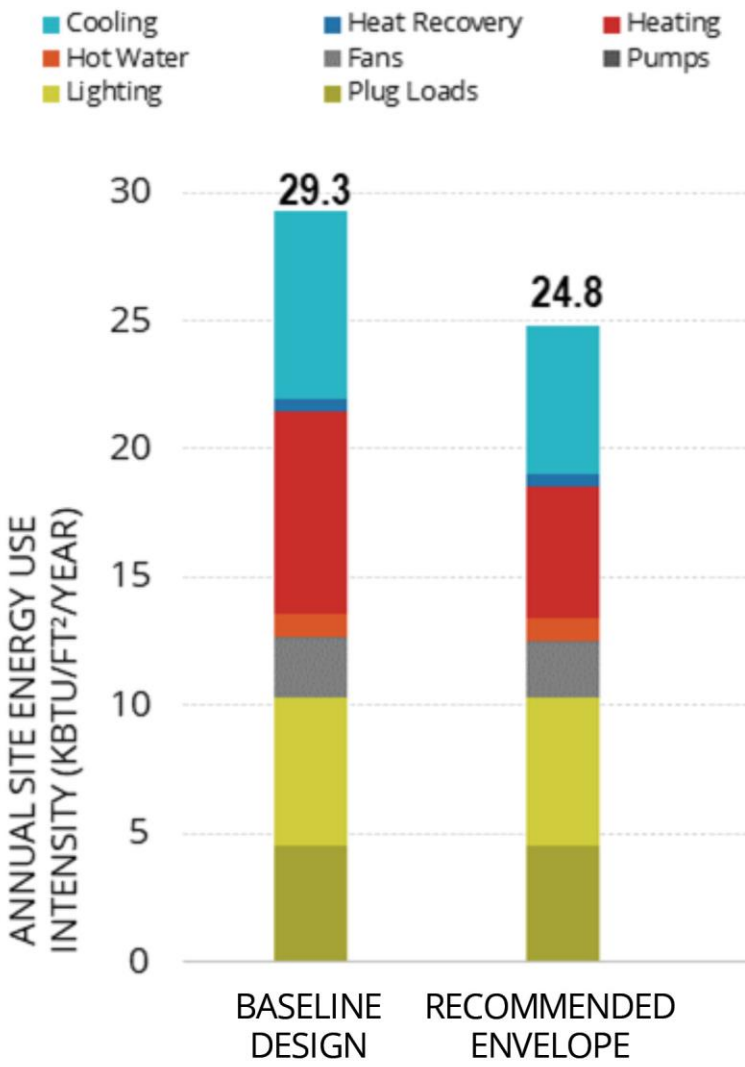
ENVELOPE CONSIDERATIONS

Air Infiltration - set ASHRAE's highest target:
.11 envelope leakage ratio (ELR75) or
7,122 cubic feet per minute (CFM75).

Existing infiltration was equal to a 100sf opening

Insulation optimization, especially at the roof.
Where was the optimal R-Value for each part of the exterior envelope?

Important to achieve daylight autonomy goals, as well as maximize the thermal efficiency of the wall.
Properly sizing the Window to Wall Ratios (WWR)
Solar shading and control devices.
Skylights for ambient lighting on upper level



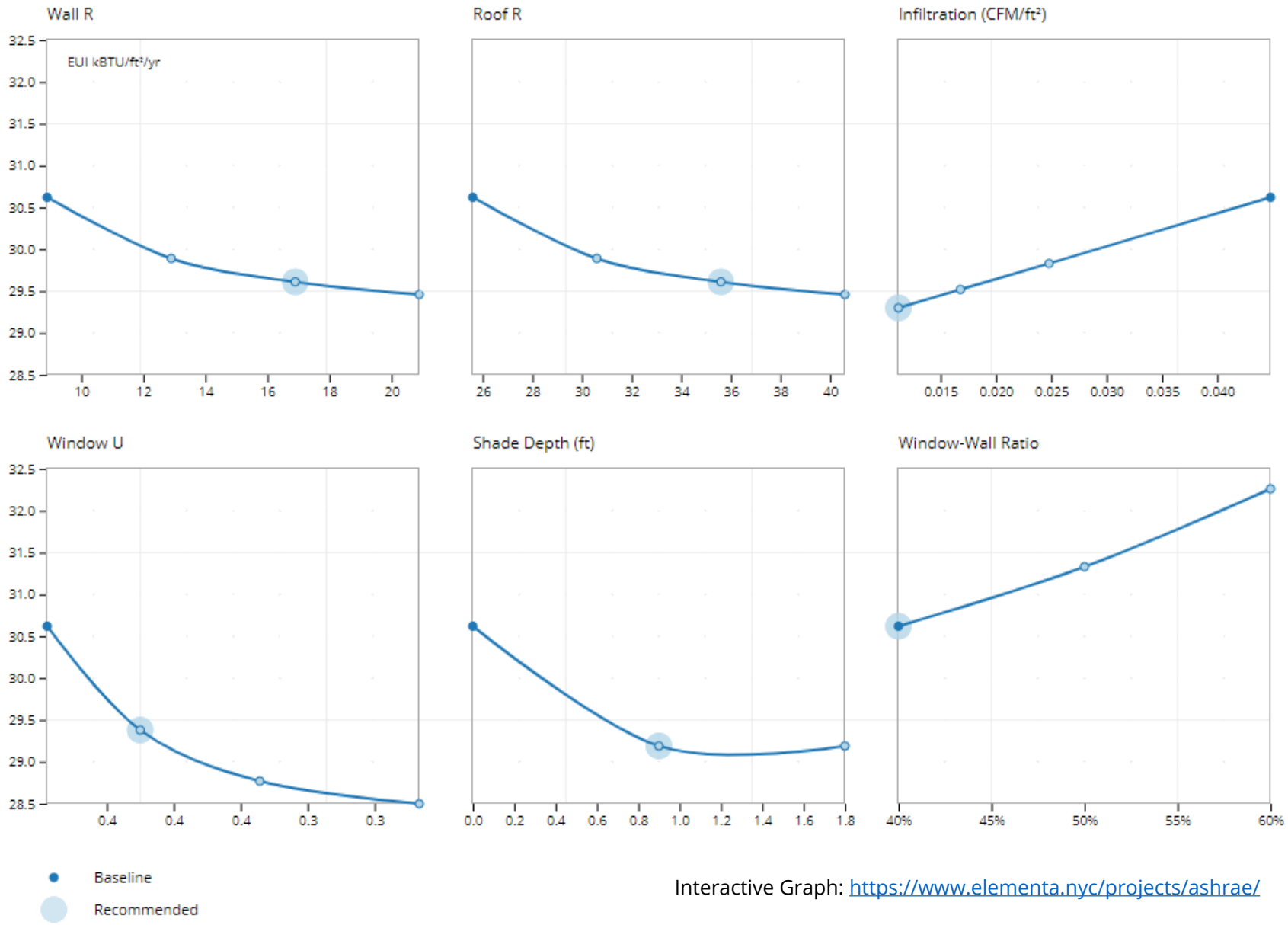
Envelope Sensitivity Analysis

ASHRAE Headquarters

Preliminary envelope performance targets based on point of diminishing Energy Use Intensity (EUI) savings shown at right:

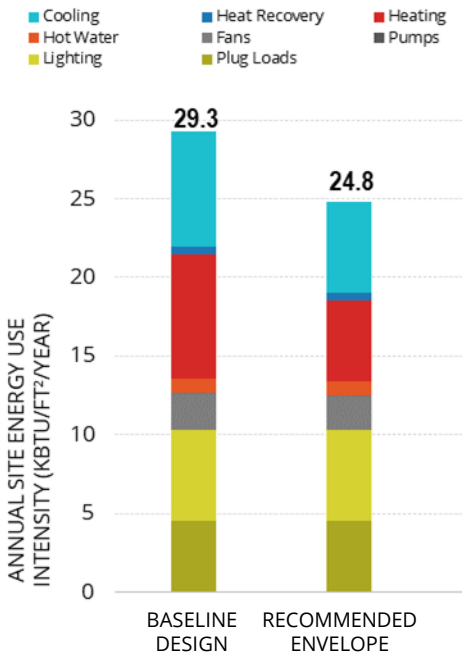
Parameter	Existing Performance	ASHRAE 90.1-2016	**Recommended**
Wall Assembly	U-0.3 (R-3.0)	U-0.122 (R-8.0)	**U-0.058 (R-17)**
Roof Assembly	U0.047 (R-21)	U-0.039 (R-25)	**U-0.028 (R-35)**
Window Assembly	U-0.59 SHGC-0.52	U-0.45 SHGC-0.25	**U-0.40 SHGC-0.25**
Window to Wall Ratio	~50%	40%	**40%**
External Shade Depth	N/A	N/A	**1'** (to be further optimized for visual, thermal comfort)
Infiltration	0.025 cfm/ft^2	0.045 cfm/ft^2	**0.011 cfm/ft^2**

ASHRAE NZE AEDG recommends R-15.6 wall for Climate Zone 3!

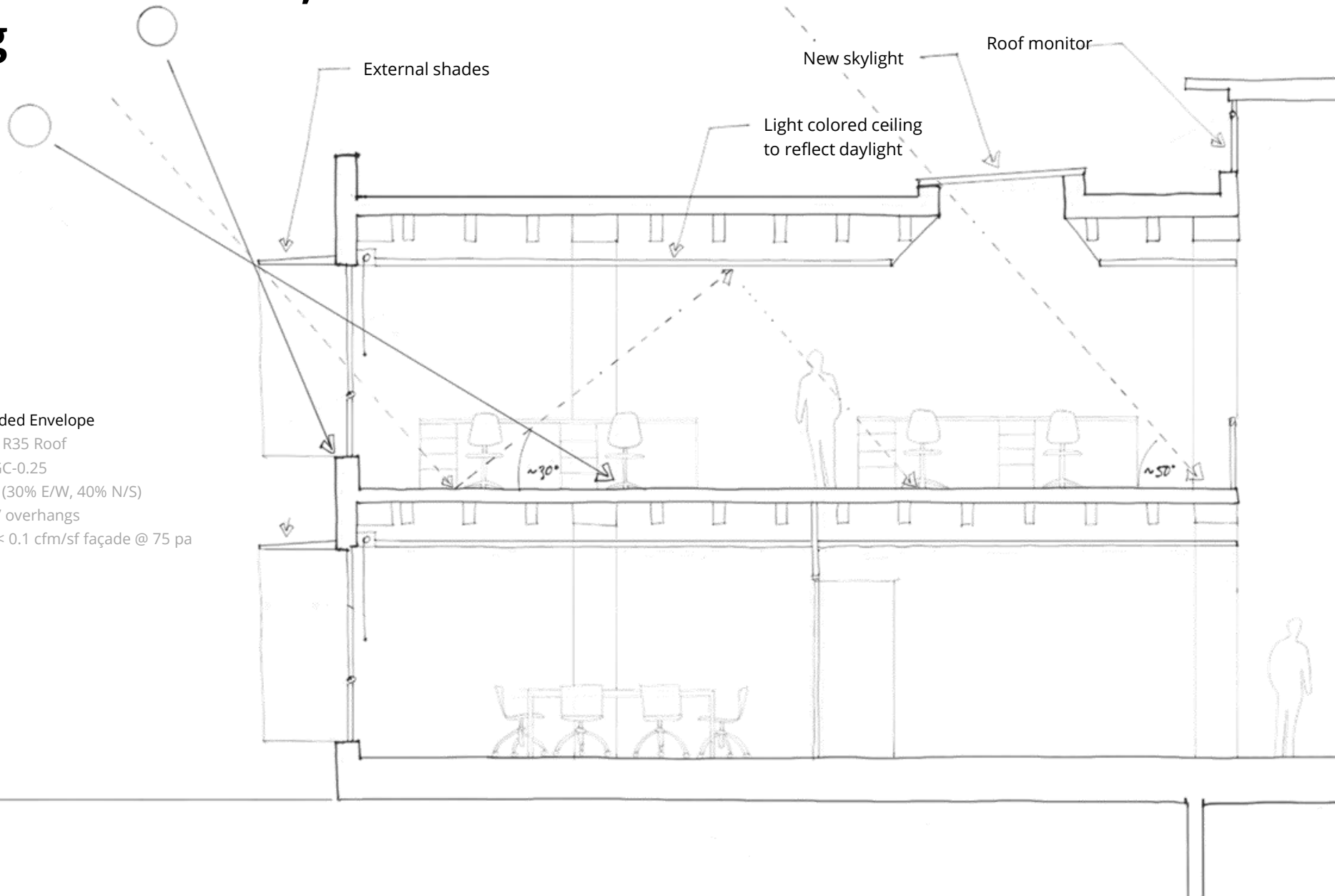


Interactive Graph: https://www.elementa.nyc/projects/ashrae/

High Performance Envelope
Insulation, Airtight Construction, External Shades, Daylighting



Recommended Envelope
R17 Walls | R35 Roof
U-0.4 | SHGC-0.25
~32% WWR (30% E/W, 40% N/S)
Minimum 1' overhangs
Infiltration < 0.1 cfm/sf façade @ 75 pa

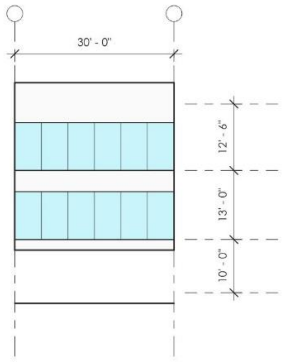


Final Window Wall Ratios

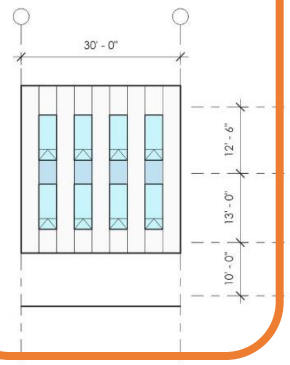
East and West

North and South

EXISTING
WWR 79.9%



WWR 33.5%



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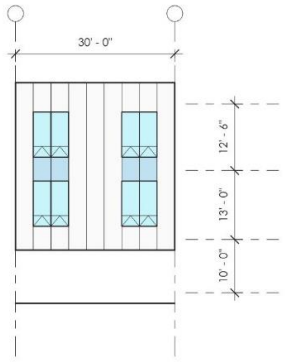

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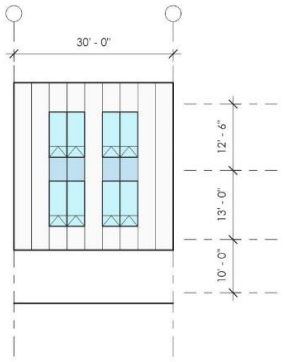
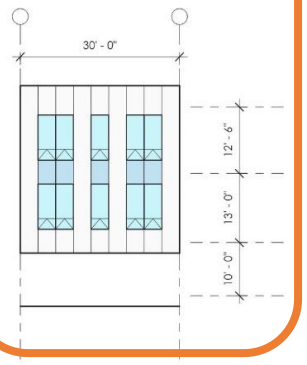
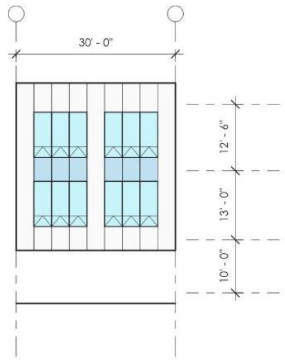


WWR 41.9%

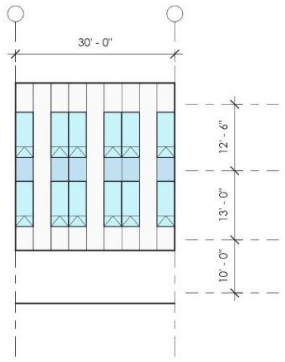


Optimo Panel Widths: 24, 30, 36, 40
Karrier Panel Widths: 24, 30, 36, 40, 42

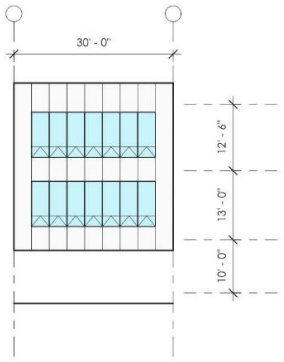
WWR 50.3%



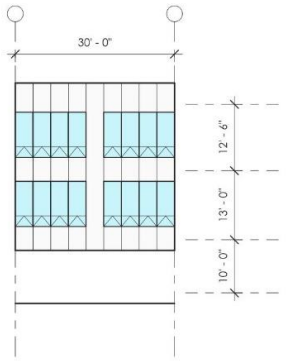
WWR 50.3%



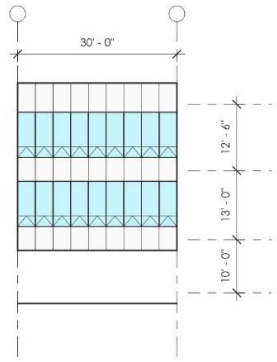
WWR 58.7%



WWR 67.1%



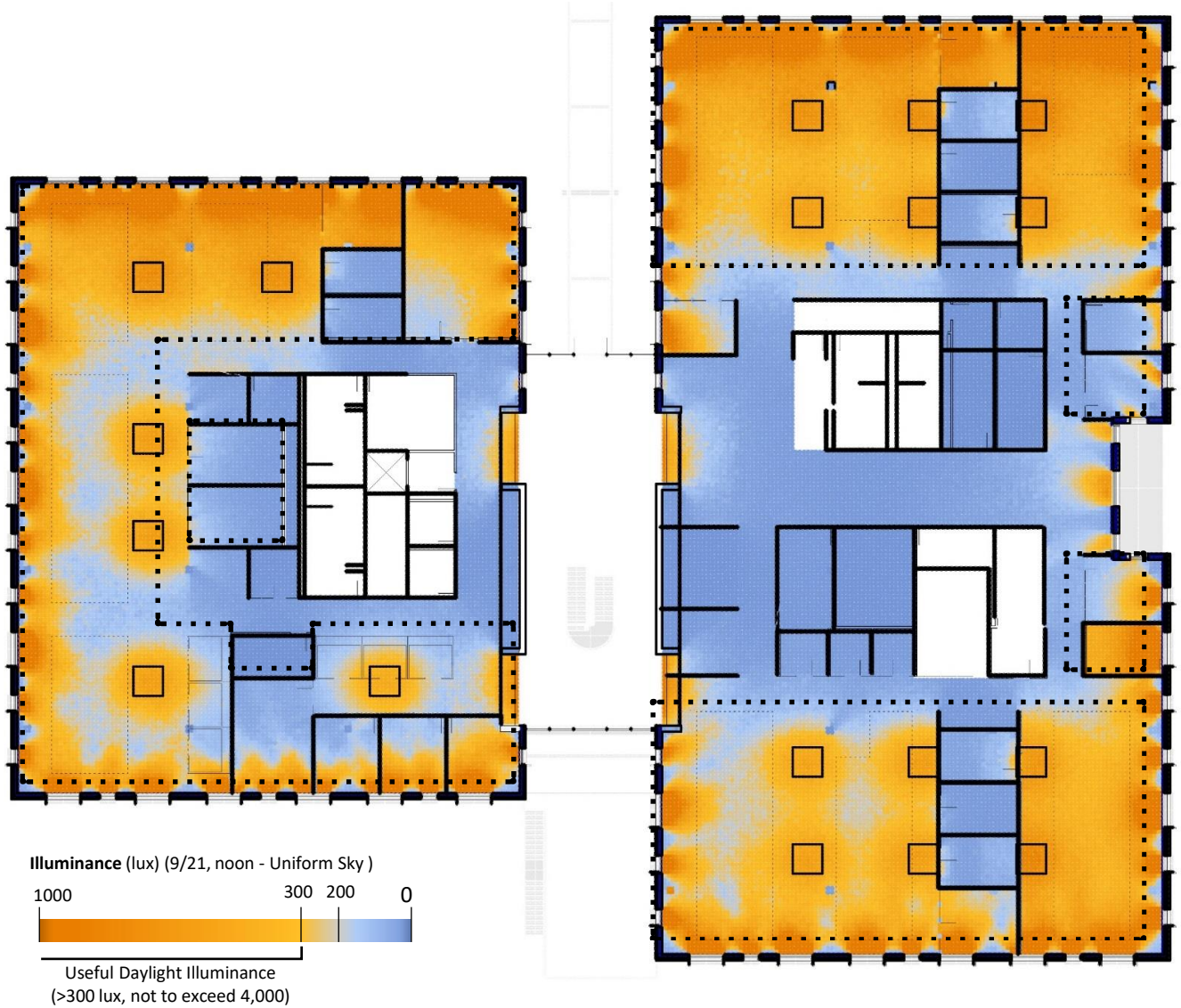
WWR 75.4%



Short Windows, 18 Skylights

57%

Percentage of regularly occupied work spaces on the upper level with useful daylight illuminance (>300 lux) at the work plane



HIGH PERFORMANCE ENVELOPE: “LIGHTLY TEMPERED” ATRIUM

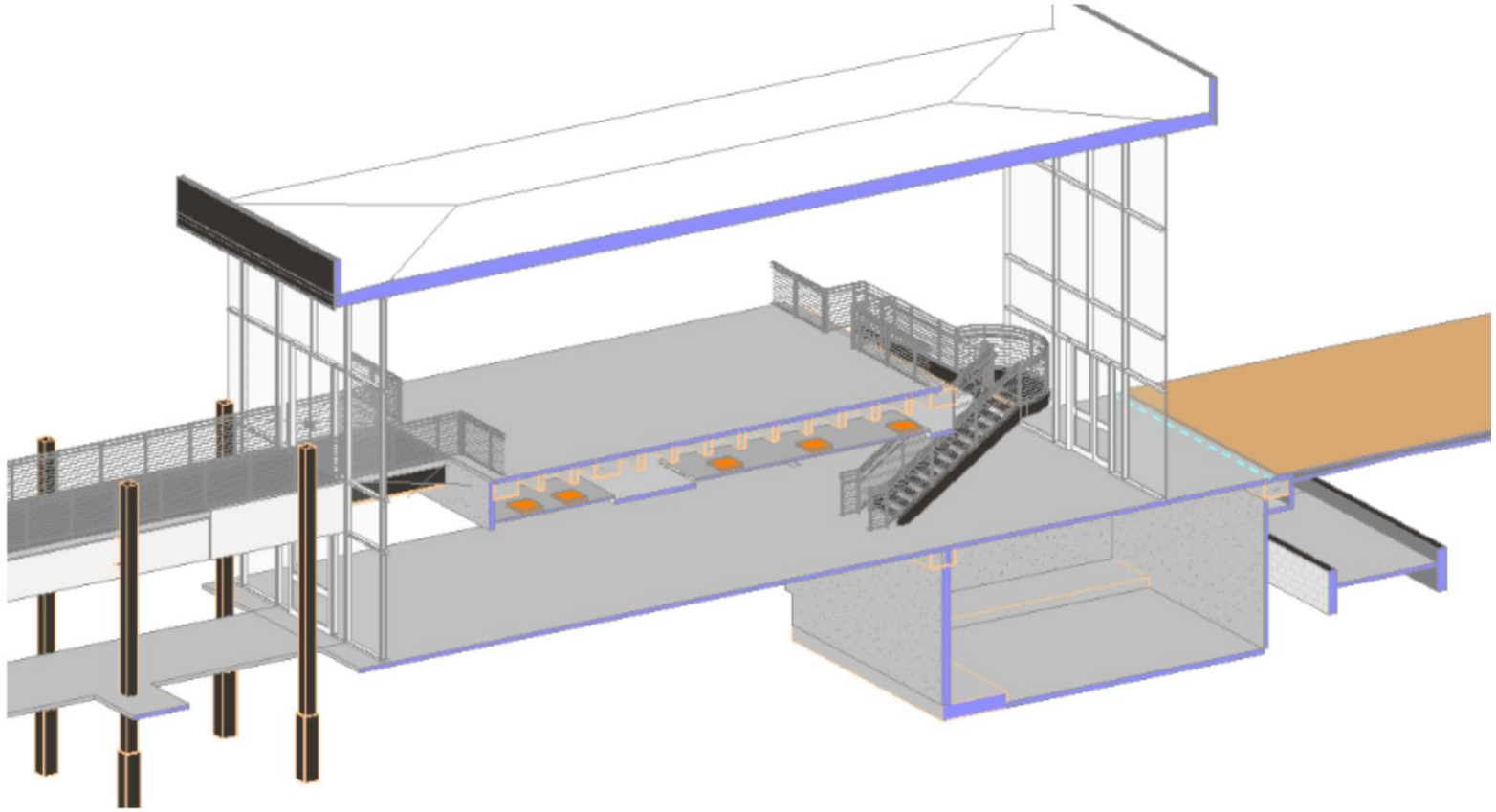
Atrium was considered as a place of movement

Higher set points, reliance on large, low velocity fans

Extensive shading on southern elevation to minimize heat gain

Skylights for daylighting

Reduced HVAC demand from 30 tons to 5 tons



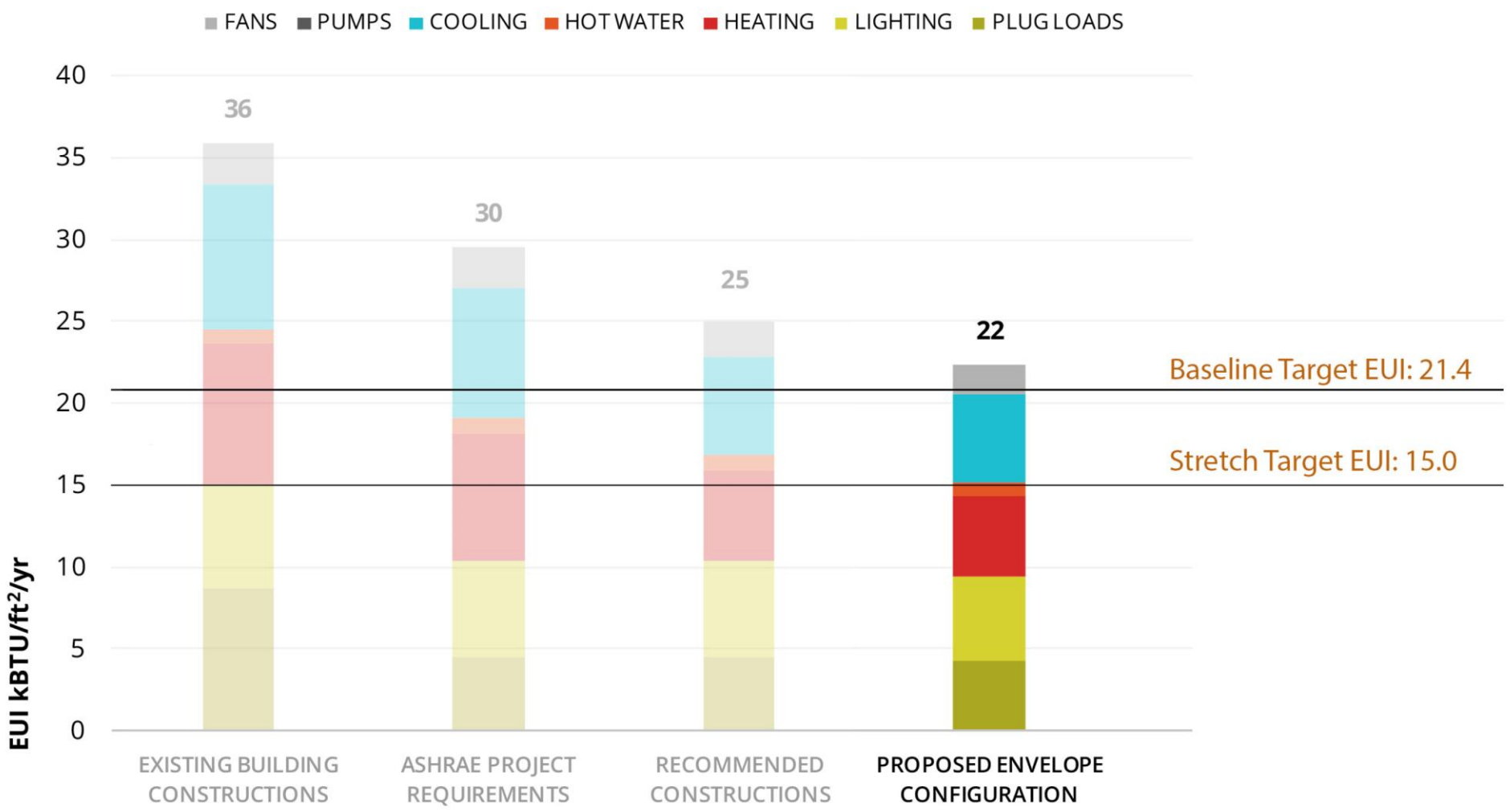
HIGH PERFORMANCE ENVELOPE: SUMMARY

Air Infiltration Rates:	.11 envelope leakage ratio (ELR75) or 7,122 cubic feet per minute (CFM75)
Window Wall Ratios:	29% on East/West walls ; 38% on North/South walls
Daylight Autonomy:	57% overall
Exterior Cladding:	EIFS with 3.5” of R5 insulation over existing. R17 overall
Window Performance:	U- 0.4; SHGC - 0.25; overhang/shade depth - 12” optimal
Skylights:	18 skylights on top floor
Roof:	R 39 total - adding approximately 4” new insulation.

HIGH PERFORMANCE ENVELOPE: EUI IMPACTS

Envelope doing the heavy lifting

Modeling showed 22 EUI before selecting a final HVACR system.



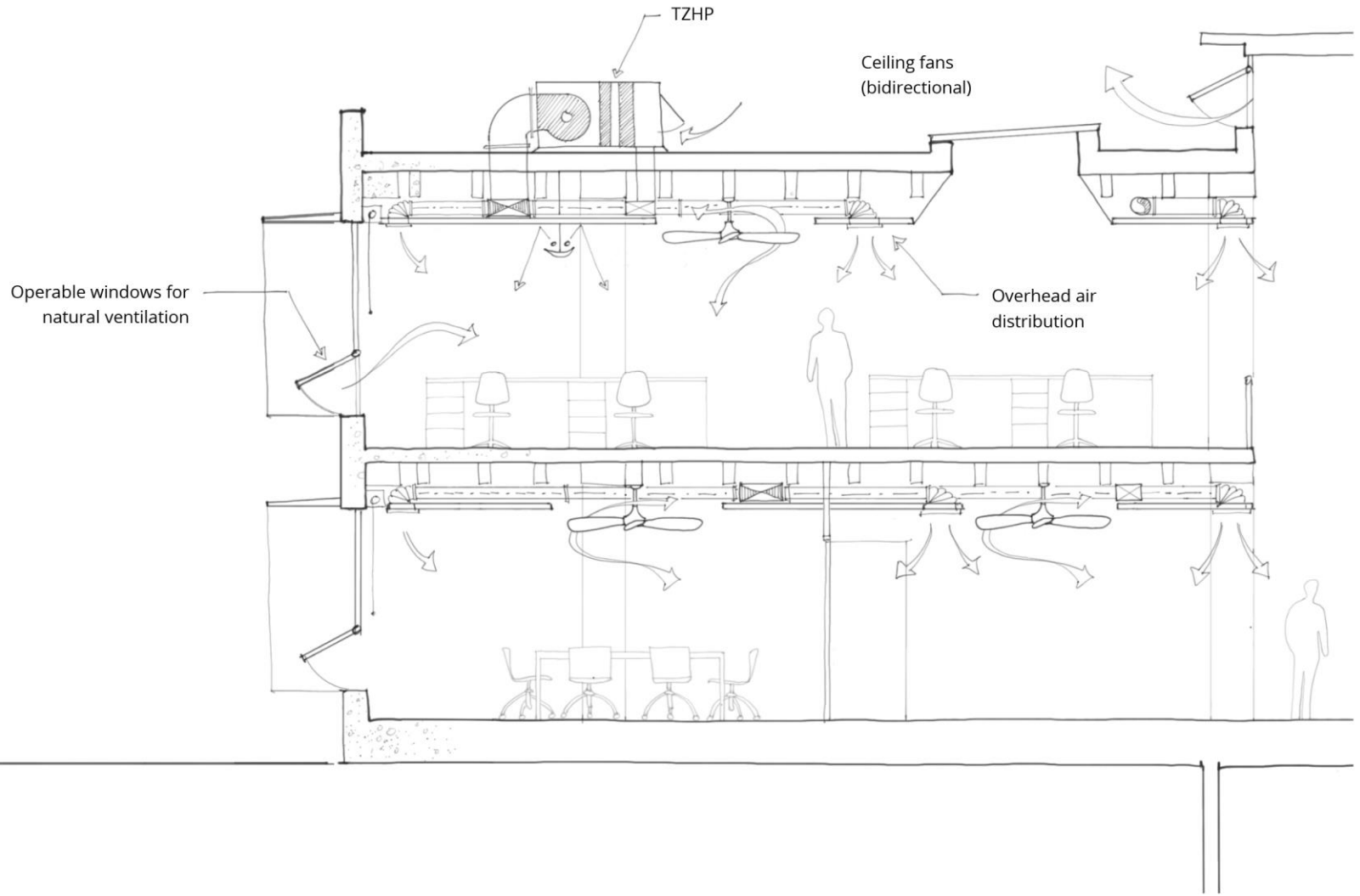
HVAC OPTION 1 - ALL AIR TZHP SYSTEM

System Type
Rooftop Packaged Thermodynamically Zoned ASHPs with DOAS, enthalpy heat recovery, DCV, and a desiccant wheel

Air Distribution Options
Overhead, Mixed Air

Mixed-Mode Ventilation
Operable windows and atrium exhaust
Ceiling fans with reverse control

Night-Flush / Airside Economizer
Fan-assisted night flush



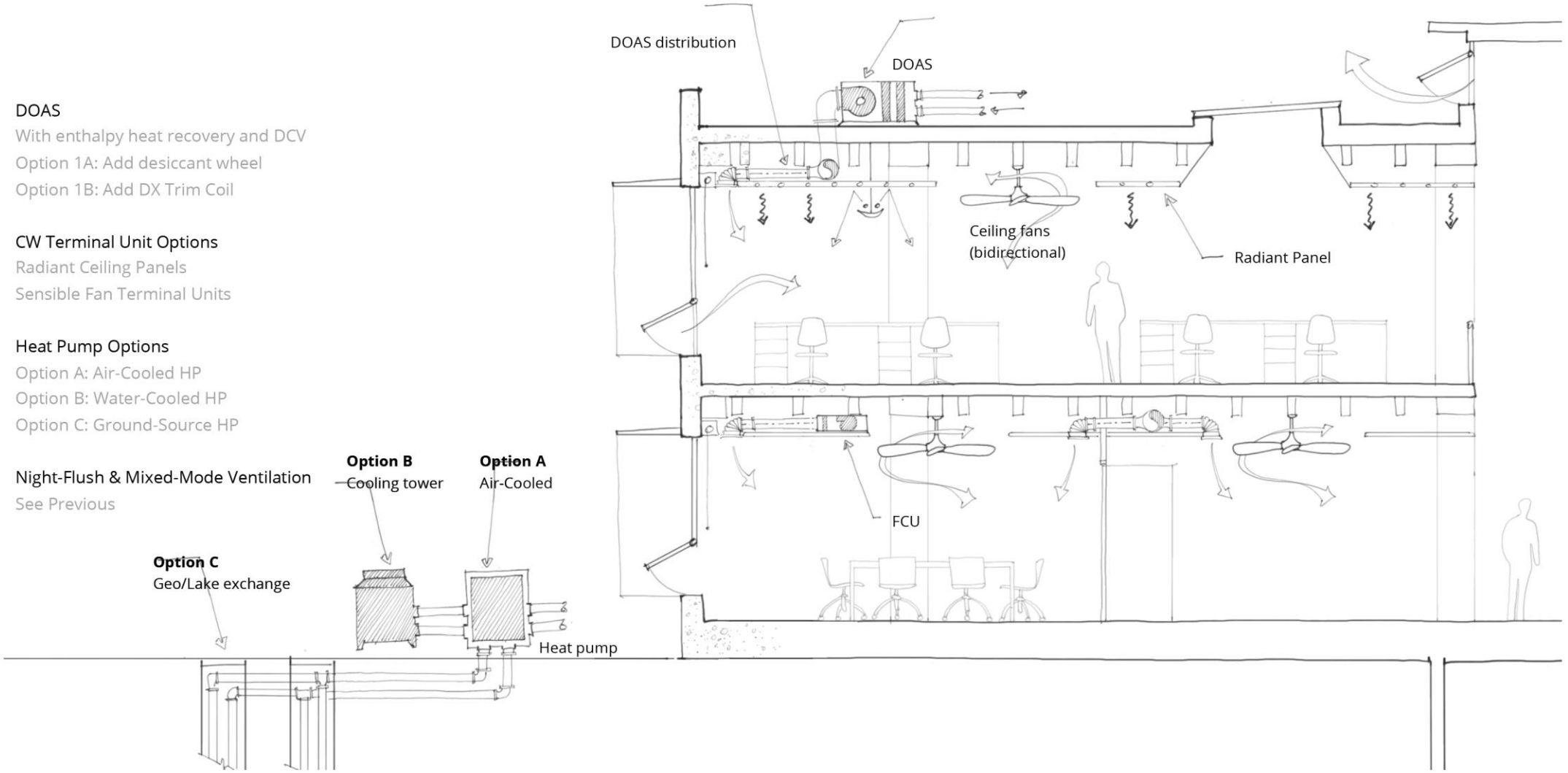
HVAC OPTION 2 - HYDRONIC SYSTEM

DOAS
With enthalpy heat recovery and DCV
Option 1A: Add desiccant wheel
Option 1B: Add DX Trim Coil

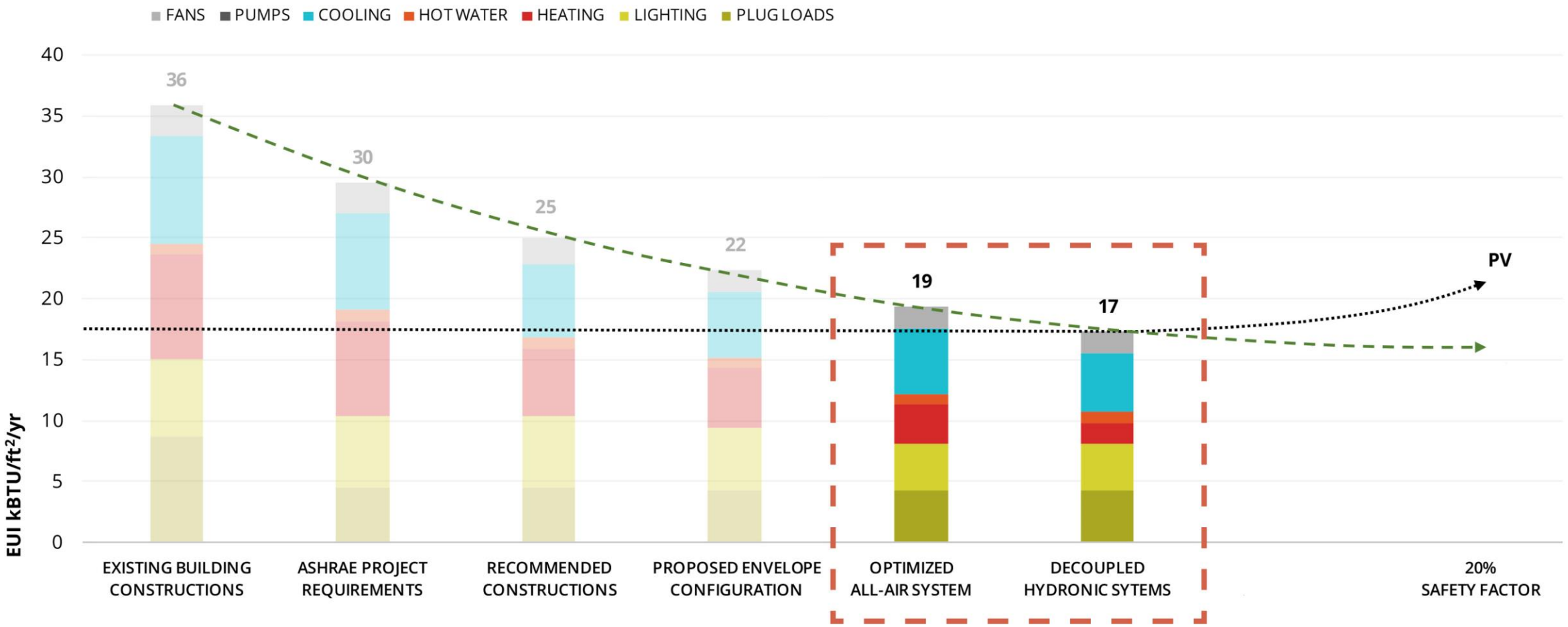
CW Terminal Unit Options
Radiant Ceiling Panels
Sensible Fan Terminal Units

Heat Pump Options
Option A: Air-Cooled HP
Option B: Water-Cooled HP
Option C: Ground-Source HP

Night-Flush & Mixed-Mode Ventilation
See Previous



HVACR SYSTEMS - EUI IMPACTS



Final EUI difference between 2 system options was 2-3 EUI

HVAC Concept Overview

Resulting System Needs

- Hydronic Systems reduce energy - Radiant
- Smaller, modular control – control valves and ceiling fans vs VAV terminal units and ductwork
- Simultaneous heating and cooling – Heat Pump and/or heat recovery machines
- Decouple temperature from humidity – DOAS
- Recover energy whenever possible

System Overview

Outdoor Air Cooled Modular Heat Pump

Staged Pumping

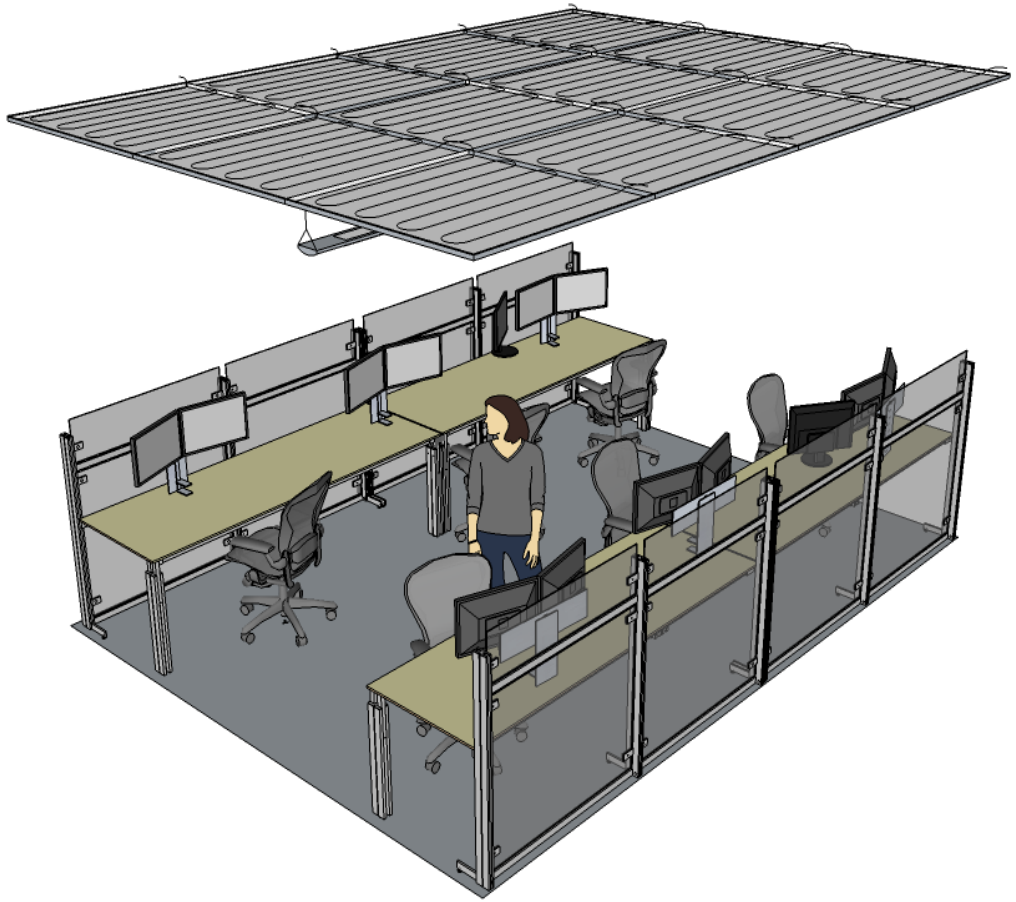
Air Cooled DOAS decoupled from waterside systems

WSHP for transient or potentially humid spaces utilize CHWR.

Overhead Radiant Panels for heating/cooling at exterior zones, cooling only at interior zones.

Ceiling Fans to induce cooling and improve environmental comfort.

Overhead Radiant Systems



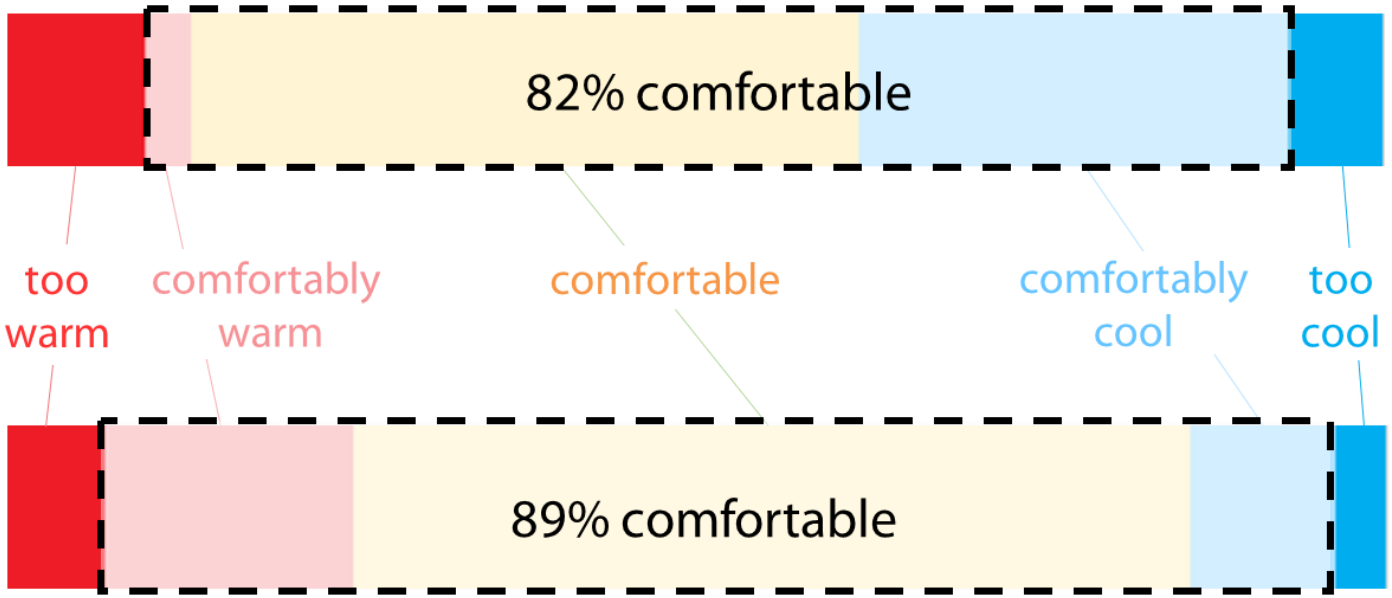
- Radiant Panels form clouds above the occupied spaces
- All heating and cooling in these spaces are provided by the panels.
- Ventilation is cool/neutral temperature air delivered directly to the space and not directly responsible for temperature control within the zone.

Supplemental Ceiling Fans

Before fan install

Indoor temperature ~ 72 ^{o}F

(n = 29)

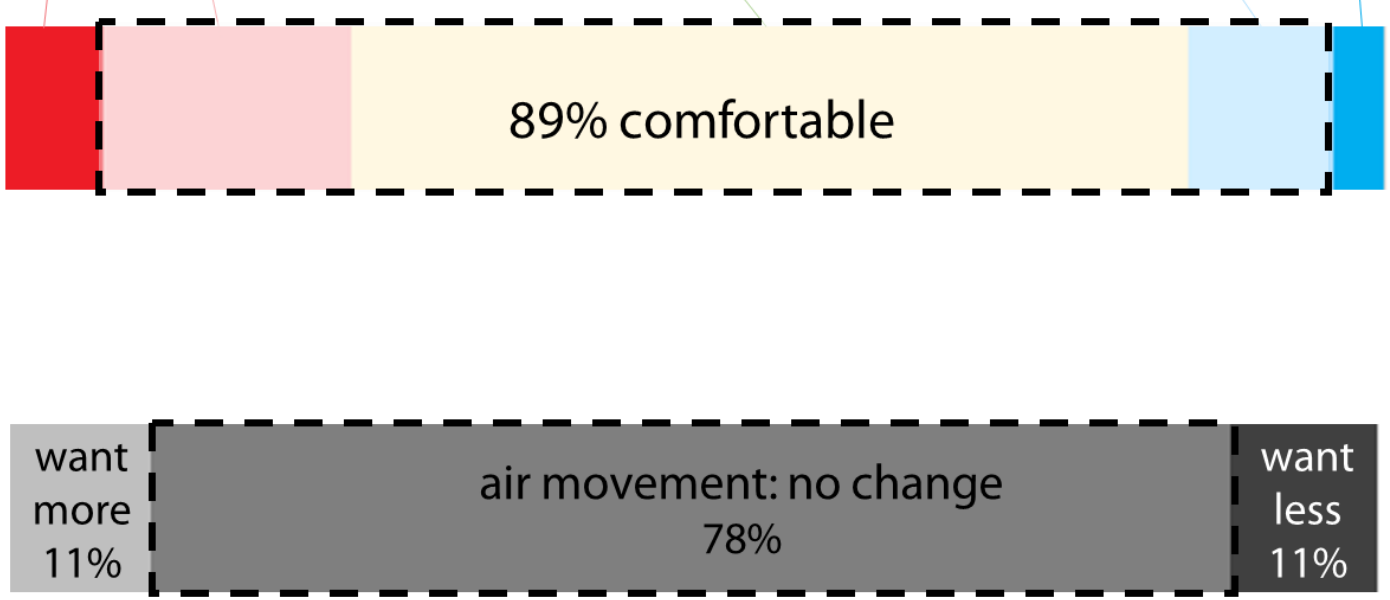


After fan install

and air conditioning failure

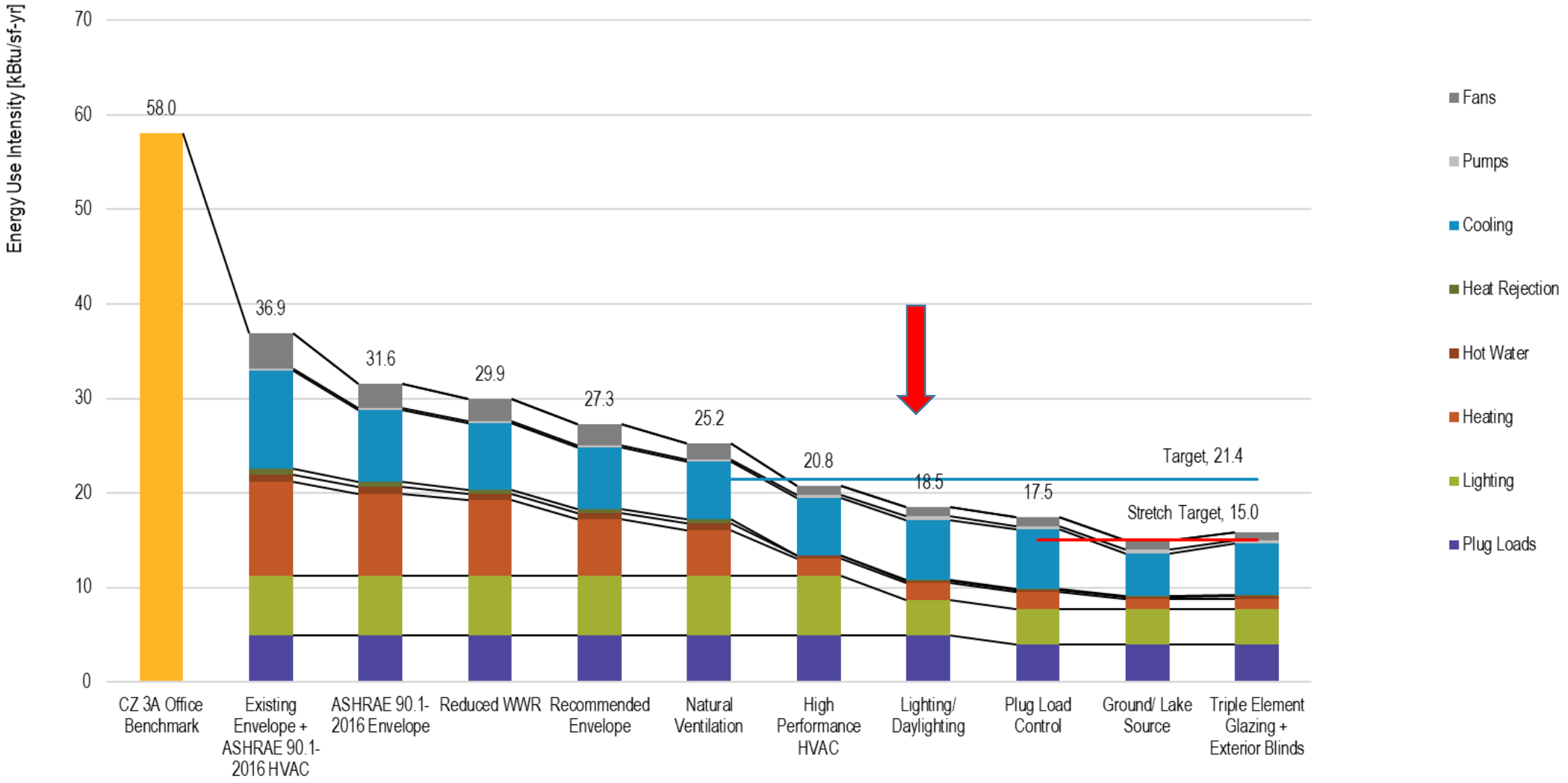
Indoor temperature ~ 80 ^{o}F

(n = 28)



Air speeds
~40 – 150 fpm

Overhead Radiant Systems



Adding Solar PV

System Size	331.88 kW DC

Estimated Energy Production (Year 1): **457,713 kWh**

Capacity:

- 250kW AC
- Capped by Georgia Power Net Metering

Costs:

- PV $500,000
- Site $50,000
- Total $550,000

Building Operations

- Building Completed in December 2020.
- Training and staff occupancy began in late 2021.

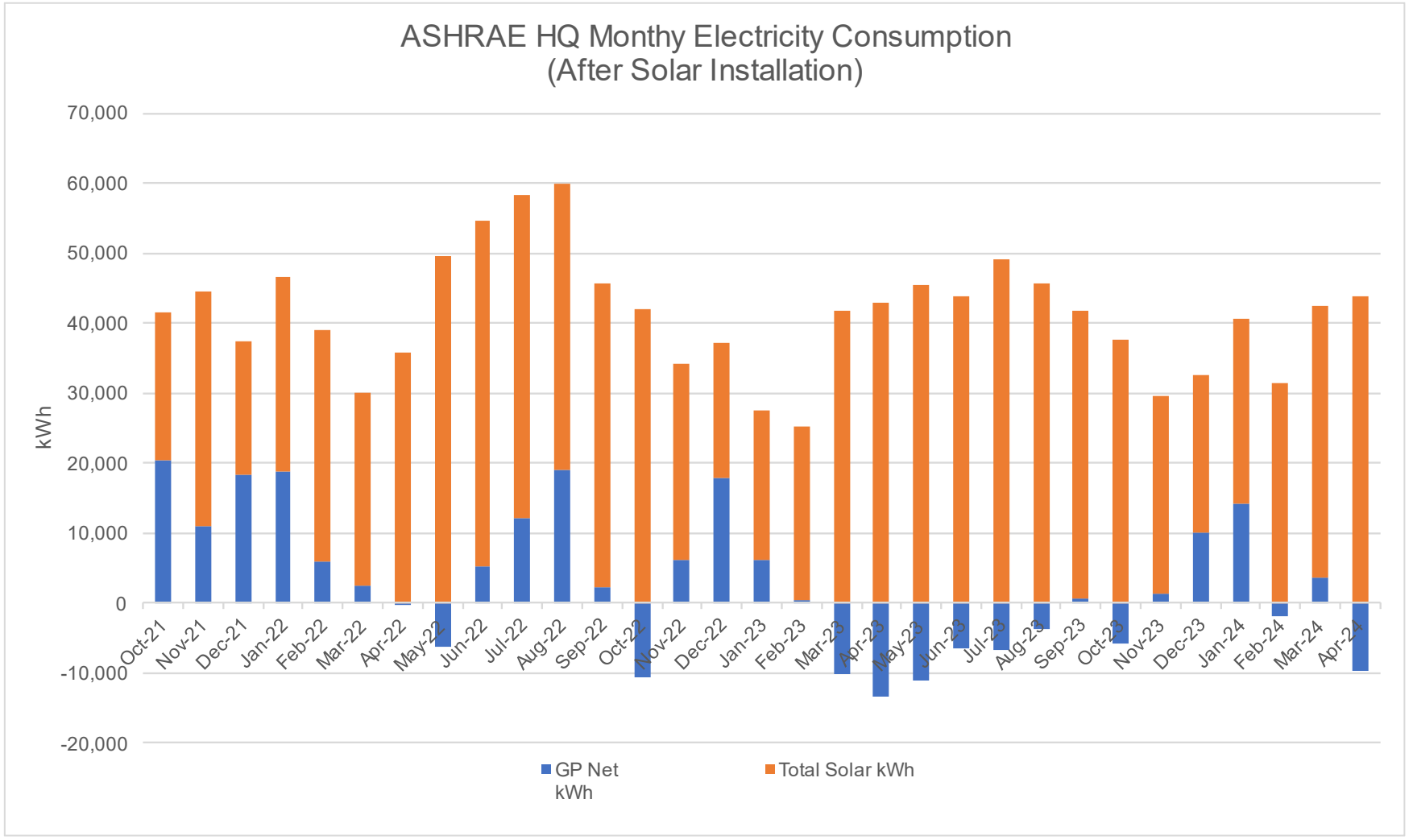
- Building analytics and fault detection
- Building intelligence evaluation using Building IQ
- Demonstration of the use of Automated System Optimization
- Building EQ evaluation
- IEQ monitoring

Conclusions

- Design for effective operations.
- Know your local construction market – capabilities, capacity, pricing, etc.
- Play into the available strengths.
- Carefully examine all existing building systems and infrastructure. Be realistic about their condition.
- There will always be unanticipated costs.
- Coordination = communication. Always be communicating.

- Do not drop the ball after completion: focus on getting the building to operate as intended.

Actual Operating




DAIKIN


Cisco Training Room

Questions:

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